

EMISSIONS INVENTORY ATTACHMENT

1. Overview

The South Coast Air Quality Management District (AQMD) is responsible for clean air in the South Coast Air Basin (SCAB or Basin), an area that includes Orange County and the non-desert portions of Los Angeles, Riverside and San Bernardino counties. South Coast Air Basin is designated as a non-attainment area for Ozone and Particulate Matter (PM). As such, the most significant air quality challenge in the Basin is to reduce nitrogen oxide (NOx) emissions sufficiently to meet the upcoming ozone standard deadline. Based on the inventory and modeling performed during development of 2016 Air Quality Management Plan (AQMP), 45% and 55% NOx emissions reductions are needed by 2023 and 2031 to meet this deadline. Mobile sources contribute to 80% of NOx emissions inventory. Therefore, any further deployment and technology advancement assist in reaching this target.

The proposed project will deliver and deploy 38 zero-emission battery electric buses (BEB) to replace diesel powered buses currently operating in the EJ community of Moreno Valley Unified school district in Riverside county California.

The emissions inventory calculated on an annual basis for the fleet of 38 buses and for the full equipment lifetime as Moreno Valley USD is committed to operating the buses for their full 12-year lifetime, which extends well beyond the project timeframe.

Criteria pollutant emissions inventory is calculated based on Tank-to-Wheel (TTW) exhaust emission factors, while GHG emissions inventory is calculated based on a Well-to-Wheel (WTW) basis.

Criteria Pollutant Emissions Inventory

The Criteria pollutant emissions inventory is calculated using TTW exhaust emission factors as provided by the California Air Resources Board ("CARB") Emissions Factor Web Database model (EMFAC2017)¹ and an average annual millage of a typical diesel powered bus. Emission factors relating the quantity of each relevant pollutant to the miles traveled per vehicle per year (grams/mile) were determined for a 2008 model year diesel powered school bus operating in Riverside County from EMFAC2017.

EMFAC2017 model inputs/outputs, detailed calculations of annual criteria pollutant emissions are shown in Section 3.

GHG Emissions Inventory

The GHG emissions inventory is calculated using CARB's calculation methodology for WTW GHG emissions. This methodology relies on calculating the fuel usage for the baseline technology and then using fuel specific values for Carbon Intensity (CI) and Energy Density (ED) to determine the associated GHG emissions. The fuel specific values for diesel are taken from the CCI Quantification Methodology Emission Factor Database (cci_emissionfactor database_111419)².

GHG emission Inventory calculations are shown in Section 3.

2. Baseline Fleet Description:

- 38 diesel powered 2007 and older model year buses
- Baseline bus usage: 3.12 mi/GGE diesel, 122 miles per day, 363 days per year

¹ <https://www.arb.ca.gov/emfac/2017/>

² <https://ww2.arb.ca.gov/resources/documents/cci-quantification-benefits-and-reporting-materials?corr>

- 44,286 miles per bus per year
- 14,194 Deq per bus per year
- 664,290 miles per year for fleet of 38 diesel buses
- 212,913 GGE- per year for fleet of 38 diesel buses

3. Criteria Pollutant Emissions Inventory

3.1 Methodology

Using the 2017 Carl Moyer Program Guidelines³, the emission inventory of each pollutant was calculated for the project lifetime (Formula C-5)

Estimated annual emissions based on mileage (tons/yr).

Formula C-5:

$$\text{Annual emissions by pollutant (tons/yr)} = [\text{emission factor(g/mi)} + \text{deterioration product (g/mi) (if applicable)}] * \text{annual activity (mi/yr)} * \text{percentage operation in California} / (\text{g/ton})$$

Note: 1) School bus fleets are well maintained and therefore there is no deterioration factor

2) 100% of travel takes place in California

Therefore:

$$\text{Annual Emissions by pollutant} = \text{Emission Factor} \frac{\text{g}}{\text{mile}} * \text{Activity} \frac{\text{miles}}{\text{year}} * \frac{1 \text{ ton}}{907,200 \text{ g}} * n \text{ vehicles}$$

3.2 Emission Factors

CARB's EMFAC2017 web database model is used to determine emission factors for each pollutant for a 2008 model year ULSD school bus operating all the time in Riverside County.

EMFAC 2017 Web Database Inputs

Data Type:	Emission Rates
Region:	Riverside County
Calendar:	Year: 2020
Season:	Annual
Vehicle	Category: UBUS
Model Year:	2007
Speed:	Aggregated
Fuel:	ULSD

³ https://ww3.arb.ca.gov/msprog/moyer/guidelines/2017gl/2017_cmp_gl_volume_1.pdf

EMFAC2017 model results: (all zero data values removed)

EMFAC2017 model results are summarized below. Only PM2.5 running exhaust is used for estimating PM emissions since there is no reduction in Tire Wear (PMTW) and Brake Wear (PMBW) will occur as a result of this replacement.

Emission Factors for Baseline Technology

	NOx(g/mi)	ROG (g/mi)	PM2.5 (g/mi)	CO (g/mi)
Emission Factors for 2007 diesel powered school Bus (from EMFAC2017 results above)	0.4918	0.0929	0.0032	51.1265

NOTE: ROG (reactive organic gases) is used instead of VOC (volatile organic compounds). According to the EMFAC2017 User guide, the ROG class is the same as the EPA's VOC class definition.

3.3 Annual Emission Inventory Calculations for Criteria Pollutants for baseline technology

Apply Formula C5 to determine tons/year of each criteria pollutant.

$$\text{Annual Emissions by pollutant} = \text{Emission Factor} \frac{g}{\text{mile}} * \text{Activity} \frac{\text{miles}}{\text{year}} * \frac{\text{ton}}{907,200 \text{ g}} * n \text{ vehicles}$$

NOx baseline technology emissions (tons/yr) =

$$\text{Annual Emissions NOx} = 0.4918 \frac{g \text{ NOx}}{\text{mile}} * \frac{44,286 \text{ miles}}{\text{year}} * \frac{1 \text{ ton}}{907,200 \text{ g}} * 17 \text{ buses} = 0.408 \frac{\text{tons NOx}}{\text{year}}$$

ROG baseline technology emissions (tons/yr) =

$$\text{Annual Emissions ROG} = 0.0929 \frac{g \text{ ROG}}{\text{mile}} * \frac{44,286 \text{ miles}}{\text{year}} * \frac{1 \text{ ton}}{907,200 \text{ g}} * 17 \text{ buses} = 0.077 \frac{\text{tons ROG}}{\text{year}}$$

PM_{2.5} baseline technology emissions (tons/yr) =

$$\text{Annual Emissions PM}_{2.5} = 0.0032 \frac{g \text{ PM}_{2.5}}{\text{mile}} * \frac{44,286 \text{ miles}}{\text{year}} * \frac{1 \text{ ton}}{907,200 \text{ g}} * 17 \text{ buses} = 0.003 \frac{\text{tons PM}_{2.5}}{\text{year}}$$

EMFAC2017 (v1.0.2) Emission Rates

Region Type: County

Region: RIVERSIDE

Calendar Year: 2020

Season: Annual

Vehicle Classification: EMFAC2011 Categories

Units: miles/day for VMT, trips/day for Trips, g/mile for RUNEX, PMBW and PMTW, g/trip for STREX, HTSK and RUNLS, g/vehicle/day for IDLEX, RESTL and DIURN

Region	Calendar Year	Vehicle Category	Model Year	Speed	Fuel	Population	VMT	Trips	ROG_RUNEX	CO_RUNEX	NOx_RUNEX	CO2_RUNEX	PM2.5_RUNEX	PM2.5_PMTW	PM2.5_PMBW
RIVERSIDE	2020	UBUS	2008	Aggregated	NG	43	7546.656	172	0.092892382	51.12653158	0.4917794	2030.361787	0.003241102	0.008856198	0.027164674

CO baseline technology emissions (tons/yr) =

$$\text{Annual emissions CO} = 51.1265 \frac{g \text{ CO}}{\text{mile}} * \frac{44,286 \text{ miles}}{\text{year}} * \frac{1 \text{ ton}}{907,200 \text{ g}} * 17 \text{ buses} = 37.437 \frac{\text{tons CO}}{\text{year}}$$